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ABSTRACT

After surveying the findings based on Project TALENT and the three followup studies, and discussing sex differences in high school students in terms of subject preference, academic achievement, occupational interests, self-evaluation, and courses taken, the author discusses the findings of a 1975 study in which approximately 1,800 senior high school students were tested as part of the standardization of a new battery of tests based on Project TALENT findings. After adjusting for changes in the socioeconomic status of students over a 15-year period, the findings indicated several trends and some fairly large changes in male-female differences in cognitive abilities. Among the changes from 1960 to 1975, differences in test scores are discussed, including a reduction in differences based on sex. (MH)

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# Trends in Male/Female Performance on Cognitive Ability Measures

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# Trends in Male/Female Performance on Cognitive Ability Measures

The findings being reported here are based on Project TALENT and related studies developing from it. Project TALENT was conceived more than 20 years ago as a national survey of students in grades 9, 10, 11, and 12. Plans were made for follow-ups for each class 1, 5, 10, and 20 years after graduation. The sampling design was developed to include about 5% of the secondary schools throughout the country. About 400,000 students in these schools spent two school days taking tests and responding to questionnaires and inventories.

The three follow-ups already completed have provided a great deal of information about the quality and characteristics of the nation's educational institutions. They have also furnished the basis for an educational and career guidance program to assist young people in planning career goals.[1] This large survey and the several follow-ups have made possible a very large number of special studies related in only an incidental way to the major purposes originally planned for Project TALENT. The data base has been used by well over a hundred persons representing a variety of disciplines to investigate specific problems.

Before presenting the data most central to the points being made in the present discussion, a number of general observations based on a survey of the results are presented. An inspection of the results, from information tests

in more than 30 specific fields, indicates that girls in the secondary schools in 1960 were definitely better informed on such matters as music, home economics, health, clerical work, theater and ballet, and foods. They also were slightly better informed than the boys about art, the bible, colors, and etiquette. On the other hand, the boys were definitely better informed on matters concerning social studies, mathematics, the physical sciences, the biological sciences, aeronautics and space, electricity and electronics, mechanics, farming, sports, law, engineering, foreign travel, the military, hunting, fishing, outdoor activities, and sedentary games. Boys and girls were about equally well informed with respect to literature, architecture, journalism, photography, "practical" knowledge, and accounting, business, and sales.

Looking at the interests expressed by these 12th grade boys and girls, we find a number of differences. Using the criterion of occupations mentioned by five times as many boys as girls as jobs they would "like very much," gives the following list: civil engineer, toolmaker, auto mechanic, electrician, fireman, aeronautical engineer, electronics technician, bricklayer, riveter, electrical engineer, mining engineer, repairman, railroad brakeman, truck driver, mechanical engineer, machinist, welder, and carpenter. Using the same criterion, five times as many girls as boys said they would "like very much" to be a : tailor or dressmaker, dietitian, airline hostess or steward, social worker, office clerk, elementary school teacher, nurse, secretary, librarian, typist, beautician, and switchboard operator. Thus,

for this list of 122 possible occupations, we find overwhelming preferences for 30 occupations. There are 18 greatly preferred by male and 12 greatly preferred by female 12th grade students.

The 205 occupational and activity items included in the Interest Inventory were grouped into 17 scales. Differences in the scores of 12th grade students on these scales of about a half standard deviation or more favoring the boys were found for scales: 701--Physical Sciences, Engineering, Mathematics, and Architecture; 703--Public Service; 708--Sports; 709--Hunting and Fishing; 710--Business/Management; 714--Mechanical/Technical; 715--Skilled Trades; 716--Farming; and 717--Labor. The girls' scores were about a half standard deviation or more higher than the boys' for scales: 704--Literary/Linguistic; 705--Social Service; 706--Artistic; 707--Musical; and 713--Office Work. Only small differences were observed for scales: 702--Biological Sciences; 711--Sales; and 712--Computation.

Although the self-descriptive personality scales were not found to have substantial predictive value for later roles and activities, they did show some differences in male and female patterns of response. Girls described themselves as having significantly more Social Sensitivity ("I never hurt another person's feelings if I can avoid it"), more Tidiness ("I am neat"), and more Culture ("I tend to have good taste"). Differences in their self-descriptions on Sociability, Impulsiveness, Vigor, Calmness, Leadership, Self-Confidence, and Mature Personality tended to be small.

Another way of quantifying, at least to some degree, the cultural

differences between 12th grade high school boys and girls in 1960 is in terms of their reports on participation in various types of activities. The activities that at least 15% more boys than girls reported they participated in "often" included: hunting or fishing; hockey, lacrosse, handball, boxing, wrestling, track, field events; mechanical or auto repair; playing baseball, football, or basketball; retail store work, delivery; building models (airplanes, ships, etc.); cabinet making, woodworking; making or repairing electrical or electronic equipment; and metalworking. The activities that 12th grade girls reported a great deal more activity in than did the boys were: cooking, sewing, knitting, crocheting, and embroidering.

Similarly, there were substantial differences between the boys and girls in terms of the courses taken between grades 9 and 12. The boys reported taking more courses in science, mathematics, and shop or vocational subjects, while the girls reported taking more courses in commercial subjects. For example, 37% of the boys as compared with 20% of the girls took at least four semesters of science; 45% of the boys compared to 24% of the girls took at least four semesters of mathematics; 17% of the boys and 4% of the girls took shop or similar vocational courses; but only 8% of the boys as compared with 33% of the girls took at least four semesters of commercial courses. There were only small differences in the proportions of the two groups taking English, social studies, and foreign languages.

What effect have these primarily culturally inspired sex differences in

preferences and activities had on the development of the cognitive abilities of the young people in this study? The survey results for grades 9, 10, 11, and 12 are shown in Table 1 for the 10 cognitive ability measures found to discriminate best between those entering various career fields. At the 9th grade level, using standard score units to eliminate the effect of the raw score metric, the boys are found to score much higher than the girls on the Mechanical Reasoning test and definitely higher on a non-verbal test of Visualization in Three Dimensions, which has been found to be a good predictor of mechanical ability and other skills requiring visualization of objects. Though the differences are smaller, the boys have significantly higher scores on the Vocabulary, Creativity, and Quantitative Reasoning tests. The girls show their greatest superiority at the 9th grade level on the English test. This test includes items on spelling, capitalization, punctuation, usage, and effective expression. A somewhat smaller but substantial difference favoring the girls is observed at this level on the Computation test. The girls also show significantly higher scores on the Reading Comprehension test. On the test of Introductory Mathematics, the girls' scores were very slightly higher than the boys', and, on the Abstract Reasoning test, there was no difference.

It is interesting to observe how these comparisons change for the higher grades. The English and Vocabulary test scores show the same substantial difference favoring the girls for grades 10, 11, and 12. On the Vocabulary test, the small superiority of the boys is maintained at all grade levels.

Table 1

Mean Scores on Ten Ability Tests for Project TALENT Students in Grades 9, 10, 11, and 12 [2]

| | Grade 9 | Grade 10 | Grade 11 | Grade 12 | Raw Score Differences Between Grades 9&12 | Standard Deviation Grade 9 | Differences in terms of Standard Scores Between Grades 9&12 |
|---|---|---|---|---|---|---|---|
| Vocabulary | | | | | | | |
| Males | 16.0 | 17.6 | 19.2 | 20.4 | 4.4 | 5.92 | .74 |
| Females | 15.2 | 16.6 | 18.0 | 19.3 | 4.1 | 5.60 | .73 |
| English | | | | | | | |
| Males | 72.4 | 76.2 | 80.0 | 82.6 | 10.2 | 14.77 | .69 |
| Females | 79.2 | 82.7 | 86.0 | 88.7 | 9.5 | 13.11 | .72 |
| Reading Comprehension | | | | | | | |
| Males | 24.6 | 27.5 | 30.8 | 33.0 | 8.4 | 10.98 | .77 |
| Females | 26.1 | 29.0 | 31.5 | 33.6 | 7.5 | 10.35 | .72 |
| Creativity | | | | | | | |
| Males | 7.7 | 8.4 | 9.4 | 10.3 | 2.6 | 3.79 | .69 |
| Females | 7.2 | 7.9 | 8.6 | 9.2 | 2.0 | 3.54 | .56 |
| Mechanical Reasoning | | | | | | | |
| Males | 11.2 | 12.1 | 12.9 | 13.5 | 2.3 | 4.04 | .57 |
| Females | 7.8 | 8.4 | 8.6 | 8.8 | 1.0 | 3.37 | .30 |
| Visualization in Three Dimensions | | | | | | | |
| Males | 8.1 | 8.7 | 9.3 | 9.7 | 1.6 | 3.29 | .49 |
| Females | 7.3 | 7.8 | 8.2 | 8.5 | 1.2 | 2.90 | .41 |
| Abstract Reasoning | | | | | | | |
| Males | 8.0 | 8.6 | 9.2 | 9.6 | 1.6 | 3.16 | .51 |
| Females | 8.0 | 8.5 | 8.9 | 9.2 | 1.2 | 3.12 | .38 |
| Quantitative Reasoning | | | | | | | |
| Males | 7.4 | 8.1 | 9.0 | 9.8 | 2.4 | 3.45 | .70 |
| Females | 7.0 | 7.6 | 8.2 | 8.8 | 1.8 | 3.28 | .55 |
| Mathematics | | | | | | | |
| Males | 9.2 | 10.0 | 11.6 | 12.4 | 3.2 | 4.18 | .77 |
| Females | 9.4 | 9.7 | 10.1 | 10.2 | .8 | 3.85 | .21 |
| Computation | | | | | | | |
| Males | 19.4 | 23.2 | 27.9 | 31.6 | 12.2 | 27.92 | .44 |
| Females | 26.9 | 28.5 | 31.1 | 33.7 | 6.8 | 21.24 | .32 |

For the Reading Comprehension test, the small difference favoring the girls is only half as large at the upper grades as at the lower levels. The small difference on the Creativity test favoring the boys becomes twice as large in the 12th grade. The very large difference favoring the boys on the Mechanical Reasoning test is maintained, with the difference between 9th and 12th grades being twice as great for boys as for girls. The fairly large difference on the test of Visualization in Three Dimensions shown by the boys in the 9th grade is also found to be greater in the 12th grade. For the Abstract Reasoning test, on which their performance was the same in the 9th grade, the boys show a mean score in the 12th grade that has a difference one-third larger than that of the girls when compared with the 9th grade score. The small difference favoring the boys at the 9th grade level becomes a fairly large difference by the 12th grade on the Quantitative Reasoning test. The most dramatic change in differences is that for the Introductory Mathematics test. At the 9th grade level, the mean score for girls was very slightly larger, but at the 12th grade, the boys' mean score was half a standard deviation higher than for the girls. The Computation test showed a similar though not so large a relative increase for the boys. The substantial difference at the 9th grade favoring the girls almost disappeared by the 12th grade.

These comparisons of mean scores for grade level groups are of considerable interest in reflecting both male/female differences and changes in these differences at various grade levels. The comparisons between grade

levels are confounded by differential dropout rates and therefore do not provide valid measures of growth. To correct for this difficulty, about 10,000 students who participated in Project TALENT in the 9th grade were retested with some of the tests three years later when they were in the 12th grade.[3] The results are shown in Table 2.

As in the norms comparisons in Table 1, the differences between grades 9 and 12 in terms of standard scores are greater for the boys than for the girls on all tests except the English test. Also, the magnitude and direction of the differences between the males and females in the 9th grade are very similar to those for the larger group. Practically the only difference is that in this smaller sample the 9th grade boys have a mean score slightly higher than the 9th grade girls rather than the same mean score on the Abstract Reasoning test. In terms of the differences between 9th and 12th grade mean scores, the retests of the same people give significantly smaller differences on the English test and the Reading Comprehension test. This tends to confirm other evidence that high school dropouts are mainly deficient in verbal skills.

The greater gains by the boys between grades 9 and 12 appear to be due primarily to the types of courses taken by the boys as compared to the girls. As noted earlier, many more boys than girls took courses in mathematics, science, and social studies. The fact that the girls took more English courses is reflected in their greater gains on the test in this field. In concluding an article reviewing some of these findings in the December 1966

Table 2

Comparison of Mean Scores on Ten Ability Tests
for Males and Females
Tested in Both the 9th and 12th Grades[4]

| | Grade 9 | Grade 12 | Raw Score Gain Grades 9-12 | Standard Score Gain Grades 9-12 |
|---|---|---|---|---|
| Vocabulary | | | | |
| Males | 17.2 | 21.3 | 4.0 | .73 |
| Females | 16.4 | 20.2 | 3.8 | .66 |
| English | | | | |
| Males | 75.8 | 83.4 | 7.6 | .51 |
| Females | 81.5 | 89.0 | 7.5 | .55 |
| Reading Comprehension | | | | |
| Males | 26.6 | 32.9 | 6.3 | .60 |
| Females | 28.1 | 34.1 | 6.0 | .59 |
| Creativity | | | | |
| Males | 8.3 | 11.6 | 3.3 | .87 |
| Females | 7.8 | 10.6 | 2.8 | .79 |
| Mechanical Reasoning | | | | |
| Males | 11.9 | 14.3 | 2.4 | .61 |
| Females | 8.2 | 9.8 | 1.6 | .47 |
| Visualization in Three Dimensions | | | | |
| Males | 8.6 | 10.4 | 1.8 | .58 |
| Females | 7.9 | 9.1 | 1.2 | .42 |
| Abstract Reasoning | | | | |
| Males | 8.8 | 10.2 | 1.4 | .47 |
| Females | 8.5 | 9.7 | 1.2 | .42 |
| Quantitative Reasoning | | | | |
| Males | 8.0 | 10.1 | 2.2 | .64 |
| Females | 7.6 | 9.2 | 1.5 | .48 |
| Mathematics | | | | |
| Males | 10.1 | 12.8 | 2.7 | .66 |
| Females | 10.2 | 11.0 | .8 | .20 |
| Computation | | | | |
| Males | 25.1 | 34.2 | 9.0 | .45 |
| Females | 30.4 | 36.5 | 6.0 | .37 |

issue of Women's Education[5] published by the American Association of University Women Educational Foundation, the present author said, "These findings suggest that the education of girls is not adequate to prepare them for future activities and roles. . . . Probably the best thing a parent can do is help the child learn more about the world of work, including the requirements for and financial advantages of some of the kinds of work for which she could prepare herself. Also more girls, perhaps, might be urged to take work that requires logical reasoning and problem solving."

The data discussed in this first section were collected in 1960 and 1963. How do they relate to the present development of abilities of girls and boys? Fortunately, an opportunity was provided in the spring of 1975 to test students in some of the same grades in a number of the schools that participated in the 1960 national survey. As part of the standardization of a new battery of tests based on the Project TALENT findings, about 1,800 students in grades 9, 10, and 11 were given the 10 Project TALENT tests discussed earlier.

Comparing student performance in the same schools over a 15-year period eliminates sampling problems in terms of school selection. However, trends in the socioeconomic level of the students served by these schools needed to be controlled. The school principals were asked to report observed changes in the communities using a 5-point scale. Differences of more than 10 percentile points were given the high and low values on the scale and differences of 5 to 10 percentile points were assigned to the intermediate values.

Differences smaller than that were assigned the middle value. These estimates were used to make small adjustments in the means for those schools where a change was reported. Four of the 17 principals estimated that the quality of the community was slightly lower; 10 reported it to be about the same; two reported their communities were slightly higher; and one principal reported that the socioeconomic status of the community served by his school was higher in 1975 than in 1960.

To get an estimate of the stability of these comparisons of the results for a single grade in a specific school in 1960 and 1975, the 17 schools in the sample were randomly divided into two halves of about equal size. Mean scores on the 10 tests were then obtained for each sex group in the three grades, 9, 10, and 11, for the two comparable samples. To obtain two independent estimates of each of the 60 mean score values, the mean scores from the 1960 and 1975 students of one sex at a specific school were weighted in accordance with the number of students from that school in this subgroup in the 1975 survey. To make these differences between 1960 and 1975 mean scores comparable for all measures, each difference in terms of raw scores was divided by the standard deviation for the 1960 scores. This procedure produced 60 pairs of independent estimates. The product moment correlation coefficient for these two estimates from random halves of the total sample was obtained. This was found to be 0.81. This coefficient provides an estimate of the consistency of the results to be expected from these half-size samples. Correcting, by using the Spearman-Brown formula to represent the entire

sample being used, yields a coefficient of 0.90.

Thus, the results from this sample as shown in Table 3 can be regarded as quite dependable in spite of the relatively modest sizes of these samples. To make the raw score differences between 1960 and 1975 as shown in Table 3 more meaningful, they have been shown as percentile differences in terms of 10th grade norms. As a first step in examining Table 3, it seems desirable to compare the 1960 results for this sample with those in Table 1. In terms of male/female differences, the results are very closely similar to those obtained by the 10th grade students in the larger sample in 1960.

Turning to changes between 1960 and 1975, there are several interesting general trends and some fairly large changes in male/female differences in terms of these cognitive ability measures. Looking at the general trends first, the scores for 1975 students are significantly lower than for the 1960 students for the tests of Vocabulary, English, Quantitative Reasoning, and Computation. The scores on the test of Reading Comprehension are very slightly lower in 1975 and the scores on the test in Introductory Mathematics are very slightly higher. Two tests show significant gains over this 15-year period--Creativity and Abstract Reasoning. The girls have improved more on the Creativity test and the boys have improved slightly more on the Abstract Reasoning test. The remaining two tests, Mechanical Reasoning and Visualization in Three Dimensions, show slightly lower scores for the boys and significantly higher scores for the girls.

This latter finding suggests that the movement to expand the interests

Table 3

Comparisons of 1960 and 1975 Results in Grades 9, 10, and 11 of Students in 17 Secondary Schools Using the Same Project TALENT Tests[6]
(For males, $N_{1975}$ = 871; for females, $N_{1975}$ = 926)

| | Raw Score 1960 | Raw Score 1975 | Changes Between 1960 and 1975 | | |
|---|---|---|---|---|---|
| | | | Raw Score | Standard Score | 10th Grade Percentile Difference |
| Vocabulary | | | | | |
| Males | 18.5 | 15.7 | -2.8 | -.48 | -17% |
| Females | 17.3 | 15.5 | -1.8 | -.32 | -11% |
| English | | | | | |
| Males | 77.3 | 73.4 | -3.9 | -.26 | -12% |
| Females | 84.5 | 79.7 | -4.8 | -.34 | -16% |
| Reading Comprehension | | | | | |
| Males | 28.8 | 28.4 | - .4 | -.04 | - 1% |
| Females | 29.8 | 29.1 | - .7 | -.07 | - 2% |
| Creativity | | | | | |
| Males | 9.1 | 10.0 | .9 | .22 | 8% |
| Females | 8.4 | 10.1 | 1.7 | .46 | 16% |
| Mechanical Reasoning | | | | | |
| Males | 12.4 | 12.2 | - .2 | -.05 | - 2% |
| Females | 8.5 | 9.2 | .7 | .20 | 7% |
| Visualization in Three Dimensions | | | | | |
| Males | 8.9 | 8.8 | - .1 | -.03 | - 1% |
| Females | 7.8 | 8.1 | .3 | .10 | 4% |
| Abstract Reasoning | | | | | |
| Males | 8.7 | 9.5 | .8 | .26 | 11% |
| Females | 8.7 | 9.4 | .7 | .22 | 8% |
| Quantitative Reasoning | | | | | |
| Males | 8.5 | 7.8 | - .7 | -.20 | - 8% |
| Females | 8.0 | 7.2 | - .8 | -.23 | - 8% |
| Mathematics | | | | | |
| Males | 10.5 | 10.7 | .2 | .04 | 2% |
| Females | 9.9 | 10.3 | .4 | .10 | 3% |
| Computation | | | | | |
| Males | 25.7 | 18.7 | -7.0 | -.27 | -17% |
| Females | 30.8 | 26.9 | -3.9 | -.19 | -11% |

and career opportunities for women is having significant impact on today's high school girls. Although the males still show much more ability in dealing with mechanical and spatial materials, the significant reduction in this difference during the past 15 years strongly suggests that this apparently culturally induced difference can be expected to change even more in the near future.

The findings from these three projects may be summarized by emphasizing the need for more study of mathematics, science, and social studies by the girls to improve their basic abilities to perform effectively in a wider range of career fields. The results also suggest that such studies will prepare these girls for generally more effective functioning in this complex scientific age.

Footnotes

[1]See American Institutes for Research. Planning career goals. Monterey, California: CTB/McGraw-Hill, 1975-1977.

[2]Taken from Table 3-1 in The American high school student by J. C. Flanagan, F. B. Davis, J. T. Dailey, M. F. Shaycoft, D. B. Orr, I. Goldberg, & C. A. Neyman, Jr. Pittsburgh: University of Pittsburgh and American Institutes for Research, 1964.

[3]See Shaycoft, M. F. The high school years: growth in cognitive skills. Pittsburgh: American Institutes for Research and University of Pittsburgh, 1967.

[4]Taken from Table 4-9 in The high school years: growth in cognitive skills (See Footnote 3).

[5]See Flanagan, J. C. Quality education for girls. Women's Education, 1966, 5, 4.

[6]Taken from Table 1 in Changes in school levels of achievement: Project TALENT ten and fifteen year retests by J. C. Flanagan. Educational Researcher, 1976, 5(8), 9-12.